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Gonadal development of the hairy mussel, *Trichomya hirsuta* (Mollusca: Bivalvia) from Lake Macquarie, New South Wales

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A histological study of reproductive periodicity in the hairy mussel, *Trichomya hirsuta*, from Lake Macquarie, New South Wales, found partial spawning throughout the year in males. Few female mussels were spawning but three peaks in gonadal development and regression suggest corresponding female activity. The gonads of both sexes underwent development throughout the year.

Keywords: *Trichomya hirsuta*, Bivalvia, reproduction, New South Wales.

Introduction

Trichomya hirsuta, the hairy mussel, is common along most of the east coast of Australia excluding coral reefs and has been recorded from Tasmania, St Vincent's Gulf, South Australia and Western Australia (Klumpp and Burdon-Jones 1982). *Trichomya hirsuta* is found on rocks, muddy substrates, seagrass beds and artificial structures (Robinson and Gibbs 1982) and is an important fouling organism. It is most prevalent in marine environments forming massive, very stable populations which may carpet the substrate (Laseron 1956).

There is little information about the reproductive development of *T. hirsuta*. MacIntyre (1959) found *T. hirsuta* reproduced thoughout the year in Lake Macquarie by observing the gonad macroscopically. My work was undertaken to quantify this observation using histological techniques.

Materials and Methods

Approximately 20 *Trichomya hirsuta* were collected every 4 weeks over a 12 month period from Vales Point, Lake Macquarie, N.S.W. (33°00'S, 151°55'E) in approximately 3.5m of water and 100m offshore. This is the site of a huge population of *T. hirsuta* which occurs as clumps of 100 to 200 mussels on the soft mud substrate. Mussels over 30mm length were selected randomly from several clumps. The sex of the mussels was not determined at this stage.

A hole was bored in the shells and the mussels fixed in either Bouins solution or 20% formal-saline. The mussels were removed from their shells and stored in 70% alcohol. A transverse piece of tissue was taken between the byssal retractor and posterior adductor muscles, dehydrated in graded alcohols, cleared in methyl-benzoate and embedded in 'Paraplast Plus' histological wax. Sections were cut at 8µm, stained with Mayer Haematoxylin and eosin-Y (Humason 1962) and mounted in D.P.X.

Individual slides were assigned to a reproductive stage, modified from Wilson and Hodgkin (1967), which is defined below. A range of reproductive stages was found in

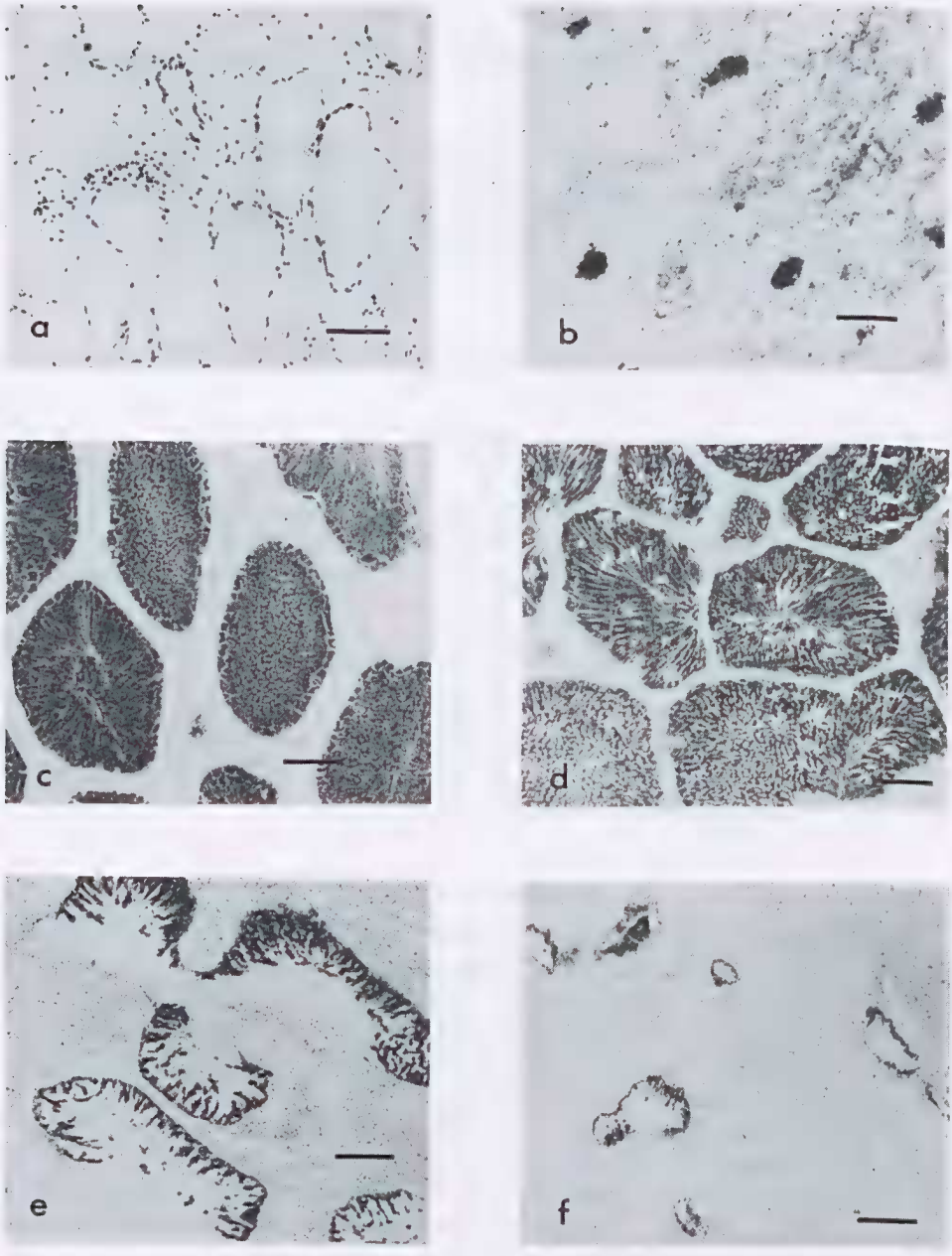

Figure 1. Male reproductive stages in *Trichomya hirsuta*. (a) resting: stage R; (b) early development: stage d1; (c) secondary development: stage d2; (d) sexually ripe: stage d3; (e) spawning: stage r1; (f) secondary: stage r2. (scale bar = 0.1mm).

individual mussels, particularly in males. For each mussel, the proportion of the gonad in each reproductive stage was estimated by scanning the entire histological section. These proportions were totalled for each stage at each sampling period and plotted.

The sex-ratio of the total sample was calculated and a chi-square test was performed to determine if it was significantly different from 1:1.

Gonad Classificatory Stages (Fig. 1 and 2).

RESTING OR INDETERMINATE (STAGE R): The sex of the mussel is difficult or impossible to determine at this stage (Fig. 1a).

EARLY DEVELOPMENT (STAGE d1): Gametogenesis begins: the tubules are small and filled with early gametogenic stages (Figs 1b and 2a).

SECONDARY DEVELOPMENT (STAGE d2): The tubules enlarge. In the male, early gametogenic stages; spermatogonia, spermatocysts and spermatids, form a wide band at the edges of the tubules (Fig. 1c). These are eosinophilic in contrast to the inner region of basophilic spermatozoa. In the female, the oogonia and early oocytes are attached to the tubule wall (Fig. 2b).

RIPE (STAGE d3): The gonads ramify throughout most tissues and little connective tissue is visible between the tubules. In the male, there is a thin, peripheral band of young gametogenic cells with ripe spermatozoa in the centre of the tubule. In the female, most oocytes detach from the wall and become polygonal due to pressure in the tubules (Figs 1d and 2c).

SPAWNING (STAGE r1): Tubules remain enlarged but spermatozoa and oocytes have been shed from the centre of the lumen and remaining oocytes become more circular with the decreased density. Breakdown of the remaining oocytes or spermatozoa begins (Figs 1e and 2d).

REGRESSION (STAGE r2): The size of the tubules has diminished and few spermatozoa and oocytes remain. A secondary development of germ cells on the tubule walls may commence (Figs 1f and 2e).

Results

Mussels of indeterminate sex (stage R) were most frequent in May. The ratio of sampled males:females:indeterminate mussels was 0.53:0.43:0.03. Ratio of males to females was not significantly different to 1:1 ($0.25<p<0.10$).

Males

No single well-defined spawning season was found for 146 male *Trichomya hirsuta* from Lake Macquarie (Fig. 3). Males in early gonadal development stage (d1) were few and found in March and May. There were three peaks of male mussels in the secondary development stage (d2), in June through August, December to February, and May: these peaks progress to stage d3 in July through September, December through February and May respectively and finally to spawning (stage r1) in December, April and June respectively. Regression (r2) coincided with spawning, with peaks in November, April and July.

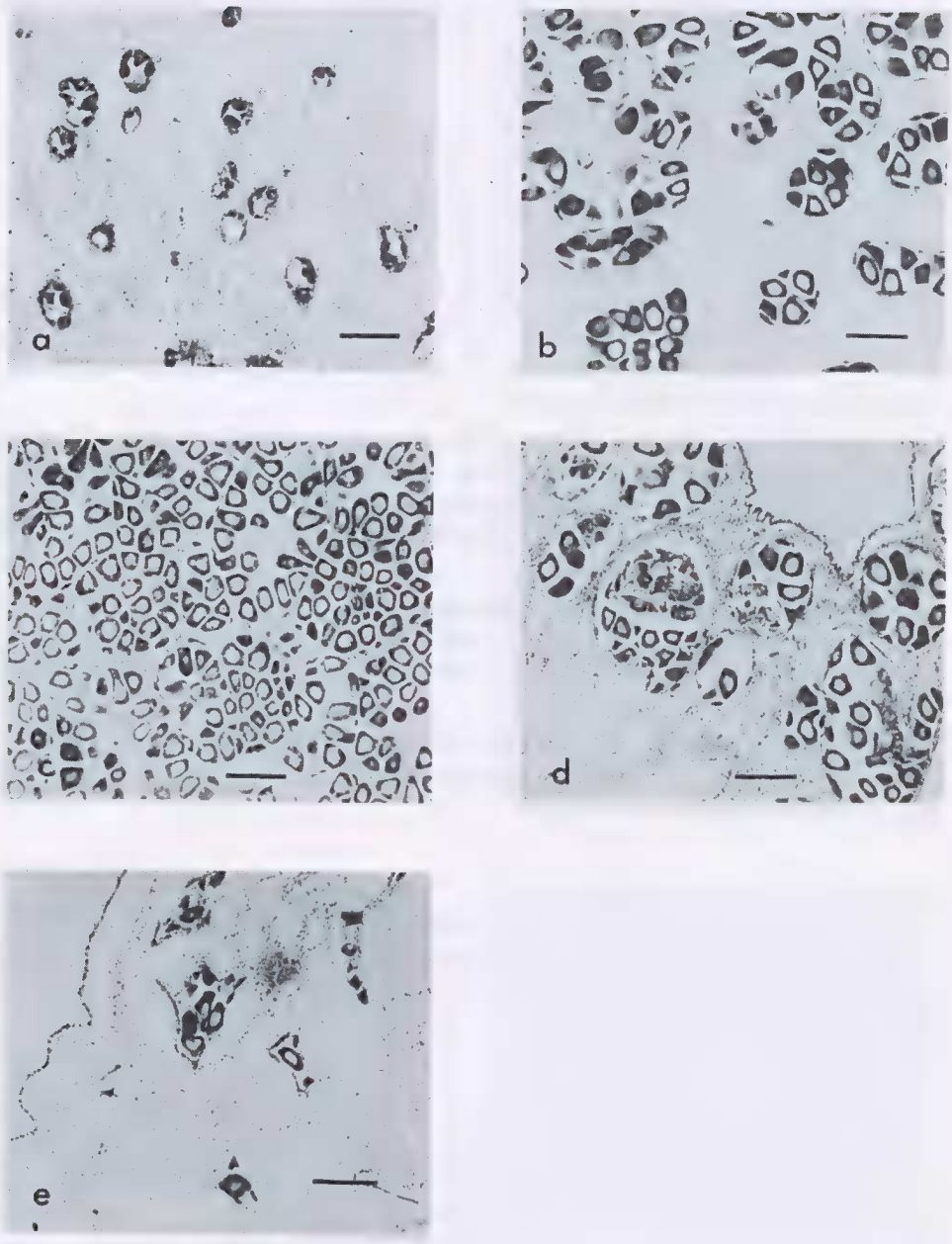

Figure 2. Female reproductive stages in *Trichomya hirsuta*. (a) early development: stage d1; (b) secondary development: stage d2; (c) sexually ripe: stage d3; (d) spawning: stage r1; (e) secondary regression: stage r2. (scale bar = 0.1mm).

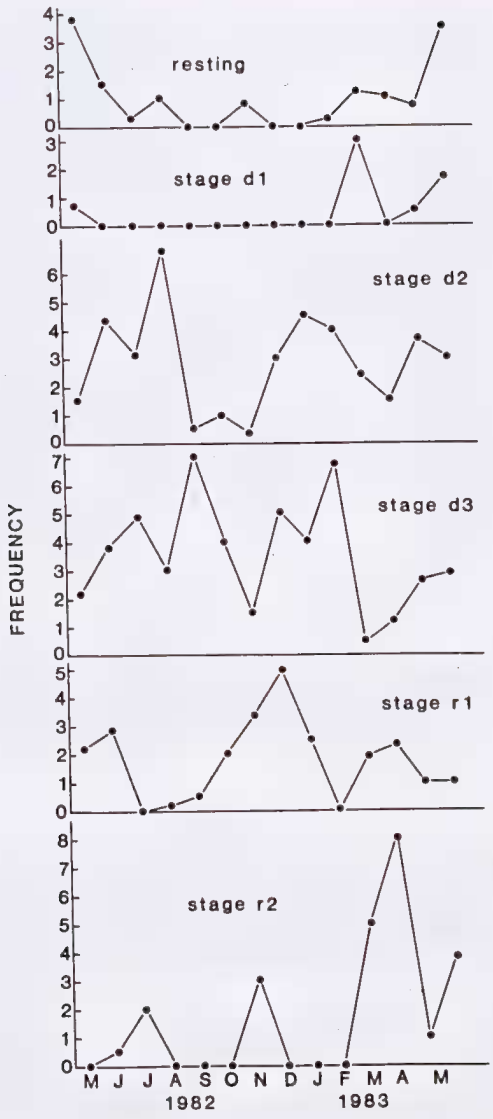

Figure 3. Seasonal incidence of reproductive stages in male *Trichomya hirsuta* (see text for derivation of frequency).

Females

No single well-defined spawning season was found for 119 *T. hirsuta* females (Fig. 4). More females than males were found in early development stage (d1) with 3 peaks in July/August, November and April/May. Females in the secondary development (d2) stage were most abundant in August through October, December to February, and May. Many females were ripe (stage d3) most of the year, particularly from September until February and in May. Spawning females were found in July, October and May. Most regressed females (r2) were found in January and March/April.

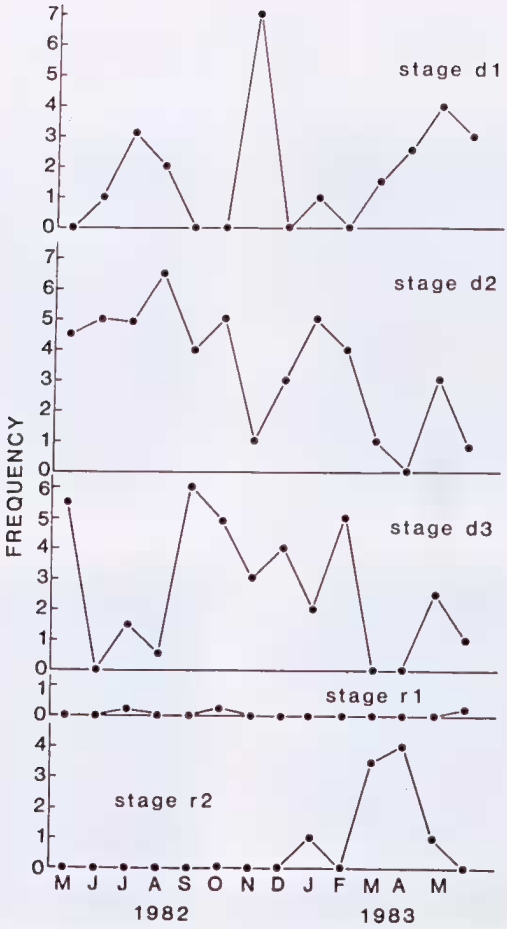

Figure 4. Seasonal incidence of reproductive stages in female *Trichomya hirsuta* (see text for derivation of frequency).

Discussion

Year-round spawning was found in male *Trichomya hirsuta* with 3 peaks in reproductive activity apparent in all stages of development. Spawning peaks were apparent for males in early winter, early summer and early autumn. Spawning of females is indicated coincident with males, by extrapolating from peaks of gonadal development. Few spawning females were found perhaps because the shedding of eggs is very brief, while redevelopment is continuous and coincides with spawning in any one tubule. Furthermore, spawning may occur in a small percentage of tubules of an individual female and be overlooked. It is probable an increased sample size would improve the resolution of the spawning period in female *T. hirsuta*.

These histological analyses support macroscopic observations by MacIntyre (1959) who found *T. hirsuta* spawning throughout the year in Lake Macquarie. Continuous spawning in *T. hirsuta* from Lake Macquarie is further supported by length-frequency data from this population. Small mussels were found throughout the year and length-

frequency data could not be resolved into modes concordant with a single specific spawning period (unpublished data). Spawning throughout the year is not uncommon in mussels and has been recorded from *Mytilus viridus* (Tan 1975) in Singapore, *Modiolus modiolus* (Seed and Brown 1975) in Northern Ireland and *Mytilus edulis* in Wellington, New Zealand (Ralph and Hurley 1952).

Wilson and Hodgkin (1967) found that temperature was a significant factor in determining reproductive activity in Australian mussels. The length of the reproductive season in southern mussels is extended in populations found further south (Baird 1976). For example, *Mytilus edulis planulatus* spawns predominantly in winter in Sydney Harbour (Allen 1955; Wisely 1964) while the reproductive season is extended in Tasmania and spawning occurs in late winter, early spring, summer and autumn (Dix and Ferguson 1984). Similarly, *Trichomya hirsuta* from Lake Macquarie have an extended period of reproductive activity. It is possible that reproductive activity of *T. hirsuta* may be restricted in populations found further north.

Year-round partial spawning and redevelopment are indicated for *T. hirsuta* from Lake Macquarie which is a successful reproductive strategy to maintain the massive populations found at this location.

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